Study of the Ground-state Configuration of Neutron-rich Aluminium Isotopes through Coulomb Breakup

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In 1949 Mayer and Jensen successfully explained the magic number in the nuclei using the spin-orbit interaction. This theory explained a vast amount of reachable experimental data in the next three decades until the ground breaking experiment by Thibault et. al.[1] in 1975 on neutron rich nuclei near the neutron magic number N ~ 20. In this region of nuclei, the ground states are dominated by intruder configurations from upper *pf* orbits [2]. Hence, this region of nuclear chart is called "*island of inversion*". Nuclei like ^{34,35}Al are lying close to this *island of inversion*. Little experimental information on ground state configuration of those isotopes are available in literature [3,4] regarding their intruder *pf-shell* contribution. Coulomb excitation is a direct probe for studying the ground state configuration of loosely bound nuclei [5,6]. Experiment S306 was performed using the existing RIB facility at GSI, Dramstadt to study the properties of the nuclei in and around the N~20 *island of inversion* through electromagnetic excitation. Short-lived radioactive nuclei were produced by the fragmentation of ^{40}Ar beam (at 531 MeV/u) on Be (8 gm/cm^2) production target at fragment separator (FRS). Secondary beam from FRS, containing ^{34,35}Al were allowed to fall on various targets [Pb for electromagnetic excitation, Carbon for nuclear excitation and without target for reactions induced by detector materials] at Cave C with the exclusive set-up for kinematically complete measurement, the FRS -LAND set-up.

The incoming beam was identified uniquely by energy loss and ToF measurements before the reaction target along with the known magnetic rigidities of FRS. Neutrons and γ-rays from the de-exciting projectile or projectile like fragments were detected by the LAND and the 4π-Crystal Ball spectrometer, respectively. Reaction fragments were tracked via the Silicon Strip Trackers and GFI detectors placed before and after the magnetic spectrometer (ALADIN), respectively. Finally, mass of the outgoing fragments were identified by reconstructing the magnetic rigidities inside ALADIN event by event using the tracker programme developed at SINP. Fig. 1 shows the γ-sum spectra of ^{33}Al obtained after Coulomb breakup of ^{34}Al. The spectrum was obtained in coincidence with ^{33}Al fragments and one neutron. These observed γ-lines are in agreement with the characteristic γ-rays of ^{33}Al reported in the literature [7]. Comparison of the measured Coulomb breakup differential cross-sections with the theoretically calculated cross-sections will help us to pin down the ground state configuration and shell inversion in these neutron-rich nuclei.

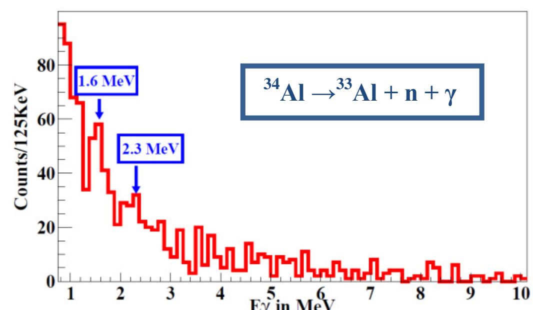

Fig. 1: γ-sum spectra of ^{33}Al obtained after Coulomb breakup of ^{34}Al in lead target.

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*Supported by Alexander von Humboldt (AvH) foundation.

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